Running head: PROSPECTIVE MEMORY IN CHILDREN

Prospective Memory in Children: The Effects of Age and Task Interruption

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Abstract

Prospective memory (PM), remembering to carry out a task in the future, is highly relevant to children's everyday functioning, yet relatively little is known about it. For these reasons the effects of age and task interruption on PM were studied in 3 experiments. Children, aged 4-, 5-, and 7-years, were asked to name pictures in stacks of cards (the ongoing task) and to remember to do something when they saw a target picture (the PM task). Significant age differences were identified, but age explained only a small amount of variance. As predicted, children in the no-interruption condition performed significantly better than those who had to interrupt the ongoing activity in order to carry out the PM task. An additional finding was that no relation was detected between performance on prospective and retrospective memory tasks. Taken together these findings provide support for current models of PM and identify ways to assist children's PM.

Prospective Memory in Children: The Effects of Age and Task Interruption

One of the recent distinctions drawn in research into memory is the difference between retrospective and prospective memory (Meacham & Leiman, 1982; see also, Brandimonte, Einstein, & McDaniel, 1996). Retrospective memory refers to remembering information acquired in the past like, for example, remembering the contents of a book, people's names, or what one did on the previous day. In contrast, prospective memory refers to remembering to carry out an intended action at some point in future such as remembering to pass a message to a friend, to make a phone call at 2 p.m. or take a pill after breakfast.

Prospective memory failures are quite common and may constitute fifty to seventy per cent of memory failures occurring in everyday life (Crovitz & Daniel, 1984; Mateer, Sohlberg, & Crinean, 1987; Terry, 1988). It is interesting that when adults comment on their own or their children's memory lapses they "often appear more concerned with instances of forgetting to carry out actions than with forgetting information about the past" (p. 291, Meacham, 1977). This is because prospective memory is a crucial component of our everyday activities so that a failure to realize that one had intended to do something at a particular moment may have unpleasant consequences by seriously disrupting one's day-to-day life at home, work or school (see Meacham, 1982; Winograd, 1988).

Therefore, an investigation of mechanisms and processes that lead to successful prospective memory performance in adults as well as children has both theoretical and practical importance. Indeed, by shedding some light on retrieval processes involved in prospective memory we could (i) substantially enhance our understanding of memory processes, and (ii) develop a set of guidelines and/or memory aids aimed at remedying the frequent occurrence of prospective memory failures in a variety of everyday settings.

Although prospective memory research has been gradually expanding over the past twenty years (particularly since 1990 when some simple and efficient laboratory methods were developed, see Einstein & McDaniel, 1990), there only exist a handful of studies on prospective memory in children (see Beal, 1988; Ceci, Baker, & Bronfenbrenner, 1988; Ceci & Bronfenbrenner, 1985; Guajardo & Best, 2000; Kerns, 2000; Meacham & Colombo, 1980; Meacham & Dumitru, 1976; Passolunghi, Brandimonte, & Cornoldi, 1995; Somerville, Wellman, & Cultice, 1983). Moreover, these studies have been conducted over considerable time intervals by various researchers who explored different variables with different tasks and, as a result, there is no coherent picture of the development of prospective memory skills in children. The scarcity of research about developmental aspects of prospective memory is reflected in the absence of a chapter on this topic in the first book on prospective memory (Brandimonte et al., 1996) as well as in a special issue of Applied Cognitive Psychology (Kvavilashvili & Ellis, in press) on prospective memory.

The paucity of findings is in marked contrast with the large (if not huge) research literature on children's retrospective memory and this disparity is particularly striking when one considers the relevance and importance of prospective memory for everyday activities. For example, children often have to remember to pass messages, perform various chores at home, take things to school, brush their teeth and so on (Nerlove, Roberts, Klein, Yarbrough, & Habicht, 1974). Moreover, several authors have expressed the view that in order to successfully cope with a variety of everyday situations, the early development of prospective memory skills may be particularly important. For example, Winograd (1988) has noted that "prospective remembering might be expected to manifest itself early in development because it is a means to an end. If one remembers to perform an activity one is rewarded. This is not the case for retrospective remembering by and large, until schooling begins with its demands on memorization of arbitrary

information" (p. 351). Meacham and Colombo (1980) even go as far as to say that "Children's attempts at prospective remembering may be an important precursor to the development of strategies for retrospective remembering" (p. 299).

It is interesting that these ideas have found initial support in a naturalistic study of Somerville et al. (1983) in which 2-, 3-, and 4-year-old children were assigned to different reminding tasks by their caregivers over a two week period. Two important findings emerged from this study. First, even with long delays of several hours, children as young as two years of age were successful at prospective remembering on at least 50% of the relevant occasions if the task was of high interest to them (e.g., "remind me to buy some candy when we are in the shop tomorrow"). Second, there was no effect of age. Two-year-olds were as good as four-year-olds in prospective memory tasks.

In light of these issues it is obvious that the experimental investigation of prospective memory in children is both important and timely. Of particular interest is, of course, the effects of age to provide information on the developmental trajectory of this form of memory. In order to develop a broader understanding of prospective memory it is also useful to investigate the effects of variables that have been identified by theoretical models as crucial for successful prospective memory. Thus, according to a model recently proposed by Kvavilashvili and Ellis (1996), interruption of an ongoing activity is an important feature of most everyday prospective memory tasks. Very often people need to interrupt the activities in which they are currently engaged when the appropriate time or occasion for the execution of an intended action arrives (Einstein & McDaniel, 1996; Maylor, 1996; Morris, 1992; Shallice & Burgess, 1991). For example, one may need to interrupt watching TV in order to make a phone call at a particular time. On some occasions, however, such interruption may not be necessary as one may wish to make an intended phone call after finishing watching TV. In other words, one has to remember to do something

after one activity has finished and before another one has started, i.e., during the gap that occurs between the two consecutive activities. Kvavilashvili and Ellis (1996) have suggested that task interruption will pose enhanced attentional demands on the individual which is likely to result in a failure to remember one's intention on time (see also Cockburn, 1995).

Finally, there is an important issue of the relationship between children's prospective and retrospective memory. There are several studies on adults that have examined the correlations between these two types of memory (e.g. see Einstein & McDaniel, 1990; Huppert & Beardsall, 1993; Kvavilashvili, 1987; Maylor, 1990) and, by and large, they have failed to obtain significant results. However, it is possible that different pattern of results will emerge in young children. For example, there is a possibility that these two types of memory are initially related and afterwards, in the course of development, become unrelated (see Guajardo & Best, 2000 for providing initial support for this conjecture).

Thus, the study was primarily designed to investigate the following three issues in relation to prospective memory. First, we wanted to study the effects of age on event-based prospective memory which involves remembering to do something in response to a certain event (e.g., remembering to post a letter when seeing a post box). Although several different types of prospective memory tasks have been identified (e.g., see Einstein & McDaniel, 1990; Kvavilashvili & Ellis, 1996), event-based tasks have been a major focus of research on adult population and therefore, in the present study, we chose to concentrate on this form of prospective memory. Second, we wanted to test our hypothesis about the effects of task interruption on prospective memory. Finally, we also wanted to look at the relationship between children's prospective and retrospective memory performance.

To achieve these three aims, we used a simple but engaging laboratory task that was specifically developed for these purposes. The children were engaged in a 'game' of naming a series of picture cards (ongoing task) and, in addition, had to remember to hide the cards which had a picture of an animal (prospective memory task). There were four stacks of cards. Prior to naming each stack children were asked to draw a picture. This was done to increase the children's involvement in the procedure, to introduce some variability into the experimental session, and to avoid ceiling effects.

Task interruption was manipulated by presenting the target pictures either in the middle of the stack of cards or as the last picture in the stack. The former required the interruption of ongoing card naming task in order to hide the target card. No such interruption was needed in the latter case since it was obvious to the child that there were no more cards to name, and that the experimenter needed to clear the table for the next task (i.e., drawing a picture). Thus, children could carry out the prospective memory task of hiding the animal card without interrupting any ongoing activity.

It is important to point out that in order to investigate the effects of task interruption in relation to Kvavilashvili and Ellis (1996) model we used a procedure which is different from that employed in previous investigations. For example, in the study of Zeigarnik (1927) participants were interrupted by the experimenter half way through a task(s) (see also Mäntylä & Sgaramella, 1997). In the present study, there was no external agent interrupting an ongoing activity when children encountered a target picture of an animal. Instead, when this picture occurred in the middle of the stack the children themselves had to interrupt their own ongoing activity. In other words, in the present study we investigated the effects of a need to interrupt a current activity, rather than externally induced interruption, on prospective memory performance.

In Experiment 1 we tested 5- and 7-year-old children. This provided a starting point for our later studies by showing that the task was suitable for young children and revealing interesting pattern of findings. In Experiment 2, an additional group of 4-year-old children and larger samples were used in order to enhance the power and the possibility of obtaining a larger effect size for age. In Experiment 3, children's retrospective recall was also tested in order to investigate the relationship between prospective and retrospective memory recall. In addition, a possible confound in the task interruption manipulation that existed in Experiments 1 and 2 was controlled for.

Our initial choice of age was dictated by the following considerations. First, research on children has produced mixed findings about whether there are age differences in prospective memory between 5 and 7 years. Meacham and Dumitru (1976) reported significant differences in performance of 5- and 7-year-old children whereas no reliable differences were found between these ages in the study conducted by Meacham and Colombo (1980; see also Kurtz-Costes, Schneider, & Rupp, 1995). Second, significant developmental changes within this period have been amply documented in retrospective memory literature (see Flavell, Beach, & Chinsky, 1966; Gathercole, 1998; Kail, 1990). For example, in a study conducted by Kurtz-Costes et al. (1995) on 5- and 7-year-old children, highly significant effects of age were obtained in as many as seven different retrospective memory tasks. In contrast, no age effect was observed in a prospective memory task in which children had to remind the experimenter to do something at the end of the experimental session. If the present study also fails to establish an effect of age on children's prospective memory performance then this finding together with that of Kurtz-Costes et al. (1995) could be indicative of an interesting dissociation between the developmental patterns in prospective and retrospective memory.

Experiment 1

Method

Participants. Forty-eight pupils were recruited from a local infant school. Half of the children were 5 years old (mean age 5 years 5 months) and half were 7 years old (mean age 7 years and 4 months). Each age group had equal numbers of boys and girls.

Design. The design was a 2 x 2 between subjects factorial in which we varied the age of participants (5 years vs. 7 years) and task interruption (no interruption vs. interruption). There were 12 participants in each of the four experimental conditions.

Materials and procedure. Eighty line drawings of concrete nouns were prepared. They were glued to orange square shaped cards (12.5 cm x 12.5 cm). Half of the drawings were taken from Snodgrass and Vanderwart (1980). The other half was prepared by ourselves. These 80 cards were divided into four stacks. In each stack there was one target card depicting an animal: this was a cow in Stack 1; a dog in Stack 2; a pig in Stack 3, and a horse in Stack 4. The presentation order of the four stacks and the cards within a stack was same for all children. However, in the interruption condition the target pictures were always placed as the tenth card in the stack, and in the no interruption condition as the twentieth, i.e., the last card in the stack.

Children were tested individually in a small room which contained a table in the center, chairs and a work surface. Children were asked to sit at the table next to the experimenter and were introduced to a toy mole 'Morris' (positioned in the center of the table) who allegedly liked to play with children very much. It was explained that moles can not see very well in daylight. The experimenter went on to say that the four stacks of cards that lay on the table belonged to Morris and that he was very curious to know what pictures were on these cards. The children were then told that they would be helping Morris by looking at these pictures one by one and telling him

as accurately as possible what were the pictures. Children were also told that Morris would be happy if they drew some pictures for him throughout the session. All children expressed willingness to draw. Thus, children had to draw a picture for Morris, then name the first stack of cards. This procedure was repeated until all four stacks of cards were named and four pictures were drawn.

After conveying these general instructions, the experimenter introduced the prospective memory task by telling the children informally that Morris was very scared of other animals. Therefore, if they happened to see a picture of an animal while naming the cards they were asked to stop what they were doing, take the card with the animal on it, and hide it in a box which was on the work surface 2 meters behind the child.[1] This step was demonstrated to the child by the experimenter (on average, it took 5-6 seconds to complete this action). Finally, the experimenter also showed the child, by using a couple of cards from the first stack, how to name the cards. One card was to be turned over at a time, the child had to name the picture and then put the card face down next to the stack. This was to be repeated until the entire stack was finished.

After this the children were asked if they had understood the instructions and the experimenter helped them to recount the tasks (including the prospective memory one). Once the experimenter was satisfied that the children were aware of what they were required to do the experimental procedure began. First, each child was given a piece of plain A4 size paper, a pencil and some felt pens and asked to draw a picture of a snowman. In subsequent drawing tasks the child was asked to draw a tree, a house, and a sheep.[2] Each drawing generally took two minutes to complete, but if the child took far less time to complete the drawing s/he was advised to add some minor details to the drawing. On completion of this task the drawing was placed next to the mole and the child was given the first stack of cards and asked to start naming the pictures by turning

over the cards one by one. No mention of prospective memory task was made at this point. For half the children in each age group the target pictures always occurred in the middle of the stacks (interruption condition), and for the other half they always occurred as the last cards in the stacks (no interruption condition). To measure the time it took a child to name each of the stacks the experimenter surreptitiously switched the stop watch as soon as the child turned over the first card in a stack and switched it off as soon as the child had named the last card in a stack.

At the end of the procedure all children were praised for their good work. After this, children who had hidden the card on at least one occasion were asked how they remembered to do this: did they think about hiding the card (1) all the time while they were drawing the pictures and naming the cards, (2) once in a while or (3) only when they saw the picture of an animal.

Those who forgot to hide the card on all four occasions were given successive questions or prompts (increasing in specificity) to find out whether their failure was due to complete forgetting of the instructions (i.e., a retrospective memory loss) or simply a failure to carry out the task at an appropriate moment. If, at the end of experiment, children could not remember that the experimenter had previously asked them to hide the animal cards then their failure could not be considered as a prospective memory failure (cf. Einstein & McDaniel, 1990; Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995; Maylor, 1993a). The first, and most general, prompt involved asking the children if, in addition to drawing the pictures and naming the cards, they were also supposed to do something else. If the children could not answer this question a second more specific question (intermediate prompt) involved asking them whether they were supposed to do something when they saw certain pictures on the cards. If the children were unable to answer this question as well they were given the final most specific prompt which involved asking them what they had to do when they saw the picture of

an animal. Finally, children were thanked, praised again and taken back to their classroom.

Results and Discussion

Children's performance on the picture-naming task was near perfect. On the majority of occasions the children produced a correct name. The experimenter also accepted understandable semantic and/or perceptual errors. If a child was unable to name a picture within four or five seconds the experimenter told him or her the correct name and the child then continued the task. It is important to note that all children, irrespective of their age, were able to correctly name the target pictures of animals.

Throughout the session children encountered the prospective memory target event (i.e., the picture of an animal) four times. As one can see from the upper panel of Table 1, 48% of children (eight 5- and fifteen 7-year-olds) remembered and 35% (ten 5- and seven

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Insert Table 1 about here

7-year-olds) forgot to hide the target card on all four occasions. The remaining 17% (six 5- and two 7-year-olds) remembered on only some (i.e., one, two or three) occasions. [3] The number of times (out of possible four) the children remembered to hide the target picture was taken as their prospective memory score. The mean scores as a function of age and task interruption are presented in the upper panel of Table 2.

Insert Table 2 about here

The prospective memory scores were entered into a 2 (age) x 2 (task interruption) between subject ANOVA. This analysis revealed a main effect of age, $F(1,44) = 5.07$, $p < .05$, indicating that 7-year-olds tended to have better prospective memory scores ($M = 2.7$) than 5-year-olds ($M = 1.7$). Furthermore, there was a highly significant effect of task interruption, $F(1,44) = 13.65$, $p < .005$. In the no interruption condition children's prospective memory scores were reliably higher ($M = 3.0$) than in the interruption condition ($M = 1.4$). The interaction between the independent variables was not significant, $F(1,44) = 1.37$, $p > .05$. It is interesting, however, that while task interruption explained a considerable amount of variability in performance (partial eta-squared .24) and had sufficient power (.95), the effect size for age was considerably smaller (partial eta-squared .10) and had insufficient power (.59).

The questioning of children at the end of experiment yielded the following data. First, post experimental probing of those 17 children (ten 5- and seven 7-year-olds) who forgot to hide the cards on all four occasions revealed that all were able to say what they were supposed to do when they saw a picture of an animal.[4] Second, the majority of those 31 children (74%) who remembered to carry out an intended action at least once throughout the session reported that they only remembered about prospective memory task when they encountered the target cards. Only 8 children (26%) said they thought about this task all the time. As one can see from the upper panel of Table 3 there were no age differences among the children in this respect, $\chi^2 = .009$, $df = 1$, $p > .05$.

Insert Tables 3 about here

The main finding that emerged from Experiment 1 is that those children who were engaged in the card naming task (interruption condition) were less likely to remember the

prospective memory task than those who had just finished this task (no interruption condition). In other words, those who had to interrupt their on-going picture naming activity in order to hide the animal cards displayed higher levels of forgetting than those who did not have to interrupt this activity. There was also a main effect of age. On the whole, 7-year-olds were better at remembering a prospective memory task than 5-year-olds. However, the size of this effect was relatively small and it did not have an acceptable level of power. Finally, the lack of interaction between the independent variables indicates that task interruption posed similar difficulties to both age groups.

Experiment 2

Given the findings from Experiment 1 we wished to confirm the effects of task interruption using a different set of materials. Second, we wished to determine whether increasing the age range would continue to produce an effect of task interruption and increase the effect of age on prospective memory scores. Consequently, Experiment 2 was conducted with a different (and improved) set of materials and instructions, and a group of 4-year-olds was included. The number of participants per cell was increased from 12 to 20.

Method

Participants. A total of 120 children were tested. Eighty pupils from two infant schools were recruited. Half of the children were 5 years old (mean age 5 years and 5 months) and half were 7 years old (mean age 7 years and 5 months). Forty children aged 4 years (mean age 4 years and 5 months) were recruited from two nursery schools. Children were tested individually in a quiet room provided by the schools.

Design. The design was a 3 x 2 between subjects factorial in which we varied the age of participants (4 years vs. 5 years vs. 7 years) and task interruption (no interruption vs. interruption). There were 20 children in each of the six experimental conditions.

Materials and procedure. Eighty line drawings of concrete nouns were prepared. This time all the drawings were drawn from Snodgrass and Vanderwart (1980), and the drawings were glued to standard-sized (15 cm x 10 cm) white index cards. The 80 drawings represented twenty categories (e.g., furniture, plants, clothing, fruits, etc.) with four examples from each category. Thus, the four stacks of 20 cards were matched for meaning and familiarity. The mean familiarity ratings of the pictures in Stack 1, Stack 2, Stack 3 and Stack 4, calculated from the normative data provided by Snodgrass and Vanderwart (1980), who used a five point rating scale, were 3.77, 3.77, 3.67 and 3.60, respectively ($F < 1$). [5] In addition, different animal pictures were used as the target cards: a deer in Stack 1, a fox in Stack 2, a rhino in Stack 3 and a bear in Stack 4. As in Experiment 1, the target pictures always occurred as the tenth card in the stack in the interruption condition, and as the twentieth (i.e., the last) card in the no interruption condition. Finally, an additional set of ten practice cards was also prepared.

The procedure of Experiment 2 was similar to that of Experiment 1 except for some minor modifications. For example, children were told that it was the mole's birthday on that day, that Morris received the four stacks of cards from his friends as a birthday present and the child was asked to draw four pictures for the mole as a present for his birthday. Initially, the children were asked to draw a picture of a boat. In subsequent drawing tasks they were asked to draw a birthday cake, a clown and a castle. Furthermore, rather than showing the children how to name the cards with two or three cards from the first stack of cards, the experimenter asked the children to have a practice go with the practice stack of 10 cards. There were no animal pictures in this practice stack.

Results and Discussion

As in Experiment 1, children encountered the target pictures of an animal four times while being engaged in naming the cards. As one can see from the middle panel of Table 1, 53% of children remembered (fifteen 4-, twenty 5-, and thirty 7-year-olds) and 36% forgot (eighteen 4-, fifteen 5-, and nine 7-year-olds) to hide the animal card on all four occasion. The remaining 11% (seven 4-, five 5-, and one 7-year-old) remembered on only one, two or three occasions.

The dependent variable was again the number of times (out of possible four) the children remembered to hide the target cards which always occurred either at the end of the stacks (no interruption condition) or in the middle (interruption condition). Children's prospective memory scores (for means see the middle panel of Table 2) were then entered into a 3 (age) x 2 (task interruption) between subject ANOVA.

This analysis revealed a main effect of age, $F(2,114) = 5.00$, $p < .01$. The mean scores for 4-, 5- and 7-year-olds were $M = 1.90$, $M = 2.20$ and $M = 3.05$, respectively. Planned comparisons showed that reliable differences existed only between 4- and 7-year-olds, $t = -3.07$, $p < .005$ and 5- and 7-year-olds, $t = -2.22$, $p < .05$ whereas the difference between 4- and 5-year-olds was not statistically reliable, $p > .05$ (all tests two-tailed). Although the effect of age was statistically significant, it is important to note that, as in Experiment 1, the effect size was again relatively small (partial eta-squared .08). This time however, due to enhanced number of subjects, we had sufficient level of power (.80).

The effect of task interruption was again highly significant, $F(1,114) = 27.34$, $p < .001$. On average, children's prospective memory performance was reliably better in the no interruption condition ($M = 3.15$) than in the interruption condition ($M = 1.63$). As in Experiment 1, this effect had a high level of power (.99) and explained 18% of

variability in performance. Finally, there was no interaction between the independent variables, $\underline{F} < 1$.

It could be argued that the superior performance of children in the no interruption condition was because they had developed an expectation that the animal card would be the last one in a stack. Such expectation or "priming" would be less likely in the interruption condition given the difficulties in keeping track of the exact (i.e., the tenth) position of the target card in the stack.

Given this argument it is therefore interesting to see whether the effect of interruption is present for the very first prospective memory target as no expectation could have been developed while children were naming the first stack of cards. The number of children who remembered or forgot to hide the first prospective memory target picture in interruption and no interruption conditions (collapsed across the age variable) is presented in the upper panel of Table 4. As one can see from this Table the effect of task interruption is still highly significant $\chi^2 = 22.94$. $\underline{df} = 1$, $\underline{p} < 00001$. The same results were obtained when similar analyses were conducted on each age group separately (all $\underline{p}_s < .01$).

Insert Table 4 about here

The post experimental probing of those 42 children (eighteen 4-, fifteen 5-, and nine 7-year-olds) who forgot their intention on all four occasions indicated that the retrospective knowledge of what they were supposed to do when they saw the picture of an animal was preserved at the end of session, they just failed to remember to perform the task in response to the target cards. It is also interesting that while 56% of 7-year-olds were able to recount the prospective memory instructions on the very first prompt (the least specific one), the majority of 4- and 5-year-olds (72% and 80%, respectively)

were able to do so only on the second or the third (most specific) prompt. This difference, however, did not achieve statistical significance, $\chi^2 = 3.48$, $\underline{df} = 2$, $\underline{p} = .17$ (see Table 5 for the raw data).

Insert Table 5 about here

In line with the results of Experiment 1, the majority (62%) of children (twenty-two 4-, twenty-five 5-, and thirty-one 7-year-olds) who remembered to carry out an intended action at least once throughout the session reported that they remembered about prospective memory task only when they encountered the target cards. Thirty-eight percent said they thought about the task all the time. As one can see from the middle panel of Table 3, there were no age differences among the children in this respect, $\chi^2 = 2.73$, $\underline{df} = 2$, $\underline{p} > .05$.

In conclusion, although Experiment 2 had different materials and increased power, it produced results that are similar to those of Experiment 1. Thus, there was a significant effect of task interruption and the analysis of the first stack suggests that this effect was unlikely to be due to expectation or "priming" in the no interruption condition. On the other hand, despite an increased power and the inclusion of a group of 4 year old children, the effect of age was again relatively small and it explained even less amount of variability (8%) than in Experiment 1. This result seems to be in a sharp contrast to the large differences in children's retrospective memory that are well documented in the literature between the ages of four and seven (e.g., Appel et al., 1972; Baker-Ward, Ornstein, & Holden, 1984; Gathercole, 1998; Sodian, Schneider, & Perlmutter, 1986).

Experiment 3

The principal aim of Experiment 3 was to compare the developmental trajectory of prospective and retrospective memory and to investigate a relationship, if any, between them. Children's retrospective memory was tested by giving them a surprise recall test immediately after they had finished naming a fourth stack of cards that were employed to assess prospective memory. In particular, they were asked to tell the experimenter what pictures they had seen in the last stack of cards. An incidental recall test was chosen because Maylor (1993a) has reported a small but significant correlation ($\underline{r}(84) = .25$, $\underline{p} < .05$) between the prospective memory successes and an incidental retrospective task in elderly participants.

Experiment 3 also provided an opportunity to answer a methodological question about the task interruption manipulation. This involves the issue of the position of the prospective memory target in a stack of cards in the interruption/no interruption conditions. In both Experiments 1 and 2, the target card of an animal always occurred in the tenth position in the interruption condition and in the 20th position in the no interruption condition. Thus, it is possible that better prospective memory in the no interruption condition was due to the animal card always occurring in the twentieth position rather than the tenth position.

In order to answer this question, children in the interruption condition in Experiment 3 had to name 20 cards in each stack with the animal card in the 10th position (same as in Experiment 2). In contrast, children in the no interruption condition received only 10 cards in each stack and the animal cards always occurred in the last, i.e., the tenth position. In this way, both interruption and no interruption conditions had the target card occurring in exactly the same position in a stack. In addition, the order of presenting the four stacks was counterbalanced so that each

stack (and its target picture) occurred equally often as the first, second, third and fourth stack.

Method

Participants. A total of 96 children were tested. Thirty-two 5 year old (mean age 5 years and 5 months) and thirty-two 7 year old children (mean age 7 years and 4 months) were recruited from a local primary school which had not previously participated in our study. Thirty-two 4 year old children (mean age 4 years and 5 months) were recruited from a nursery class attached to the school. Children were again tested individually in a quiet room provided by the school.

Design. The design was a 3 x 2 between subjects factorial in which we varied the age of participants (4 years vs. 5 years vs. 7 years) and task interruption (no interruption vs. interruption). There were 16 children in each of the six experimental conditions.

Materials and procedure. These were the same as in Experiment 2 except for the changes described above. Thus, the target pictures always occurred as the tenth card in the stack both in the interruption and in the no interruption condition. In the interruption condition there were 20 cards in each stack whereas only the first ten cards of each 20 card stack were used in the no interruption condition. The presentation order of the cards within each stack was same for all children in both conditions. However, the presentation order of the target pictures was counterbalanced since each stack occurred equally often as the first, second, third and the fourth stack. Finally, when children finished naming the last stack of cards they were asked to recall all the pictures from that stack. The experimenter recorded the proportion of correctly recalled items, the proportion of incorrectly recalled items (i.e., the items from the preceding stacks) and the number of confabulations (i.e., new items not seen in any of the four stacks of cards), if any.

This recall test was followed by the same post experimental probing of those children who forgot to hide the card on all four occasions as in Experiments 1 and 2. None of the children in Experiments 1 and 2, who remembered to hide the card on at least one occasion, responded that they thought about the prospective memory task once in a while. Consequently, this option was dropped and the order of presenting the remaining two questions (i.e., did you think about hiding a card all the time or only when you saw an animal card?) was counterbalanced in order to avoid the possibility that children were choosing only the last option (see Johnson & Harris, 1994 for children's tendency to choose a last option when presented with alternative choices).

Results and Discussion

The analyses conducted on children's prospective memory scores are reported first. This is followed by an analysis of the retrospective memory data. Finally we present the results from multiple regression analyses which examine the relation between children's prospective and retrospective memory performance.

(a) Prospective memory performance. The dependent variable was the number of times (out of possible four) the children remembered to hide the target cards. These data (for means see the lower panel of Table 2) were entered into a 3 (age) x 2 (task interruption) between subject ANOVA. This revealed a main effect of age $F(2,90) = 3.34$, $p < .05$. The 7-year-olds had better prospective memory scores than 5- year-olds who, in turn, had better scores than 4-year-olds ($M = 2.87$, $M = 2.37$, and $M = 1.72$, respectively). Planned comparisons of the means showed that reliable differences existed only between 4- and 7-year-olds ($t = -2.57$, $p < .02$) whereas the difference between 4- and 5-year-olds and 5- and 7- year-olds were not statistically significant (both $p_s > .05$) (all tests two-tailed).

There was also a main effect of task interruption ($F(1,90) = 9.77$, $p < .005$) so that children's prospective memory performance was better in the no interruption condition ($M = 2.90$) than in the interruption condition ($M = 1.75$). There was no interaction between the independent variables ($F < 1$). It is interesting that the effect size for age was similar to those obtained in previous experiments (partial eta-squared .07). However, the effect size for task interruption was not as large as before (partial eta-squared .10).

Another finding that was replicated from Experiment 2 was that the effect of task interruption was present on the very first target picture ($\chi^2 = 3.86$, df = 1, $p < .02$) indicating that this effect was not due to an expectation that the picture of an animal would be the last one in a stack (for raw data see the lower panel of Table 4). Furthermore, the post experimental probing of those 38 children (eighteen 4-, twelve 5-, and eight 7-year-olds) who forgot to hide the target card on all four occasion showed that 87% could remember the prospective memory task when prompted. There were only five children (two 4- and three 5-year-olds) who could not recount the task even after the third most specific prompt. However, after the experimenter described a task to them, they were all able to recognize the task by admitting that it had been given to them but that they had completely forgotten about it. It is worth noting that when the data of these five children were excluded from the analyses of variance reported above the same pattern of results was obtained. Finally, while 50% of 7-year-olds were able to recount the task on the very first prompt, all the 4- and 5-year-old children could do so on only the subsequent more specific prompts (see Table 5).

When those 58 children who remembered to hide the target card on at least one occasion were probed after the experiment as to whether they remembered about the prospective memory task only when they encountered the animal card or whether they were thinking about this all the time seven children (four 4-, two 5-, and one 7-year-old)

said that they did not know. This type of response, which was not present in Experiments 1 and 2, could be due to the fact that in the present experiment there was a short delay between finishing the last stack of cards and the beginning of probing. The majority of remaining children (67%) indicated that they remembered about the prospective memory task only when they saw the animal picture. Although more 5- and 7-year old children tended to report that they were thinking about hiding the target card all the time than 4-year-olds (see the lower panel of Table 3) this difference was not statistically significant - $\chi^2 = 1.89$, $df = 2$, $p > .05$.

(b) Retrospective memory performance. The mean proportion of intrusions (i.e., the number of items recalled from the first three stacks divided by the total number of items in those stacks) and the mean number of confabulations was so small (less that 1% and less than one, respectively) that they could not be subjected to an analysis of variance. Despite such low numbers of intrusions and confabulations the proportion of correctly recalled items from Stack 4 was far from perfect, most probably due to the incidental nature of the recall task (see Table 6 for means).

Insert Table 6 about here

In order to determine if there were developmental changes in children's incidental retrospective recall a proportion of correctly recalled items was entered into a 3 (age) x 2 (task interruption) between subject ANOVA as a dependent variable. This analysis revealed a main effect of age, $F(2,90) = 7.67$, $p < .005$. Planned comparisons of the mean proportions of correctly recalled pictures ($M_1 = .13$, $M_2 = .15$ and $M_3 = .24$ for 4-, 5- and 7-year old children, respectively) showed that there was no difference between the recall of 4- and 5-year old children ($t = .69$, $p > .05$) but there was a highly significant

difference between 5- and 7-year-olds (t = -2.99, $p < .005$) and 4- and 7-year-olds (t = -3.68, $p < 001$) (all tests two-tailed).

There was also a main effect of task interruption ($F(1,90) = 19.78$, $p < .001$) so that children in the no interruption condition had reliably better recall scores (M = .23) than in the interruption condition (M = .12). This finding was not surprising given that the former had to recall a list of only ten items whereas the latter had to recall a twenty item list. In the memory literature a decreased probability of recalling an item as the number of items in the list increases is called a list-length effect (Ohrt & Gronlund, 1999; Strong, 1912). Therefore, it should be obvious that in case of incidental retrospective recall the effect of task interruption was actually tantamount to the list-length effect. In other words, what counted as a task interruption variable for the prospective memory task was actually a list length variable for the retrospective memory task. Finally, there was no interaction between the independent variables ($F < 1$) indicating that the effect of age was significant in both 10 and 20 item conditions.

The effect size for the age was .15 and for the list-length it was .18. Both effects had a high level of power (.94 and .99, respectively). If children were warned about the recall test before the beginning of the fourth stack the effect size for age could have been even larger due to the fact that the older children would have used more efficient strategies (e.g., Flavell et al., 1966; Gathercole, 1998). Nevertheless, it is interesting to note that age explained twice as much variability in children's retrospective recall (15%) than in their prospective memory scores (7%). [6]

(c) The relationship between prospective and retrospective memory. In order to examine the relationship between prospective and retrospective memory scores we conducted a multiple regression analysis on prospective memory scores with the retrospective memory scores, age in months, and task interruption (as a dichotomous variable) as predictors. We chose this form of analysis since both prospective and

retrospective memory scores were affected by such variables as age and task interruption, and these influences could affect the detection of the relationship between the two memory scores. All predictor variables were entered simultaneously. The standardized beta coefficients and the percentage of explained variance are listed in Table 7. As one can see from this Table the only significant predictor of prospective memory performance, when all other variables were controlled for, was task interruption. It is interesting that a different pattern of results emerged when similar multiple regression analysis was conducted on retrospective memory scores. As one can see from Table 7, in addition to task interruption, children's age in months was also a significant predictor of retrospective scores when all the other variables were controlled.

Insert Table 7 about here

In conclusion, the results of Experiment 3 replicate the findings of Experiments 1 and 2 with respect to the effects of age and task interruption on children's prospective memory performance. In addition, there were different profiles of results for children's retrospective and prospective memory scores. Finally, the results of the multiple regression analyses indicated that children's performance on prospective and retrospective tasks was unrelated when effects of other variables (i.e., age and task interruption) were controlled.

General Discussion

The aim of the present set of experiments was to explore the effects of age and task interruption on event-based prospective memory. An additional issue concerned the relationship between children's prospective and retrospective memory performance. By meeting these objectives we hope to be able to start to remedy the

existing gap in the literature on developmental aspects of prospective memory which is particularly surprising given the acknowledged importance of prospective memory in helping children to cope with various everyday tasks like, for example, carrying out family chores.

A major finding concerns the effects of age on prospective memory. There is an ample evidence in the literature that, over the age range that was studied in the present experiments (4 to 7 years), children's performance in explicit retrospective memory tasks shows an appreciable improvement and this has been attributed to changes in children's storage and processing functions (see Gathercole, 1998). In contrast, our findings indicate that although 7-year-olds performed better on prospective memory tasks than 5- and 4- year-olds, the effects of age were not large. Thus, in all three experiments age explained only 7% to 10% of variability in prospective memory. Furthermore, the regression analyses conducted in Experiment 3 showed that children's age was not a significant predictor of prospective memory performance when the effects of other variables (such as task interruption and retrospective memory recall) were controlled.

These results are largely consistent with earlier findings from laboratory and naturalistic studies which failed to detect reliable age differences between 5- and 7-year-olds (Kurtz-Costes et al., 1995; Meacham & Colombo, 1980), and 2-, 3- and 4-year-olds (Somerville et al., 1983). They also can be seen as providing support for Winograd's (1988) claim that, in comparison to retrospective memory, prospective memory skills develop at a relatively early age. Indeed, in a pilot study we were surprised at young children's high level of performance and had to introduce several modifications into our basic procedure in order to eliminate the ceiling effects in 5- and 7-year old children.

It is important to note that even with these modifications the majority of 7-year-olds in the no interruption condition still remembered to hide the card on all four occasions (i.e., performed at ceiling) especially in Experiments 2 and 3 (see Table 1). Therefore one could argue that the effects of age obtained in the present study were masked or substantially reduced. If this was the case then one would expect to obtain much larger effects of age in the interruption condition in which there was a scope for a substantial improvement for older children due to the absence of any ceiling effects. However, one way ANOVAs with age group as a between subject variable conducted separately on the interruption and no interruption conditions showed that the amount of variability in prospective memory explained by age in both conditions was still relatively small and of comparable magnitude (7% and 10% in Experiment 2, and 10% and 6% in Experiment 3, for the interruption and the no interruption conditions, respectively). Moreover, none of the age effects obtained separately for these conditions reached the conventionally accepted level of statistical significance(i.e., $\underline{p} < .05$). The difference in effect sizes was much larger in Experiment 1 (20% and 3% in the interruption and no interruption conditions) but as indicated earlier this experiment lacked sufficient power due to small number of participants. On the whole, this pattern of results does not seem to support the idea that an age effect was masked by older children performing at ceiling in the no interruption condition.

In summary, the findings reported in previous studies and our own indicate that the developmental changes in prospective memory in early childhood are modest and sometimes difficult to identify. It is intriguing that similar findings have been obtained in research on elderly. For example, in her review of the literature on aging and prospective memory, Maylor (1993b) concludes that “prospective memory is much less impaired by age than retrospective memory” (p. 547)(see also Rendell & Thompson, 1999).

Of course, developmental changes in prospective memory might occur when a larger age range or a different type of prospective memory task is employed. It should be remembered that Kurtz-Costes et al. (1995) found that there was no difference in performance of 5- and 7-year old children, but there was a significant difference between the latter and 9-year-olds. Similarly, Kerns (2000) who recently developed an ingenious task for studying time-based prospective memory in children (requiring more self-initiating and monitoring) found a reliable (albeit modest) effect of age in a sample of 7- to 12-year old children. It is obvious that in the future, research on children's prospective memory should concentrate on wider age ranges and different types of tasks in order to determine the long term developmental trajectory of prospective memory.

A second important finding from our set of experiments involved the effects of task interruption on prospective memory. Although a need to interrupt an ongoing task in order to carry out an intended action has been generally agreed as a defining feature of many everyday prospective memory tasks, this important dimension (i.e., interruption vs. no interruption) has never been directly subjected to investigation.

Preliminary data relevant to this issue have been recently obtained by Cockburn (1995, 1996) from a clinical adult population. In her studies, patients had to remember to terminate an ongoing task after exactly five minutes. Cockburn concluded that "if there is a hierarchy of levels of self-initiation, tasks that require interruption of an ongoing action may represent the most demanding level" (p. 95, 1995). Unfortunately, it is not clear from the Cockburn's report whether her patients failed to remember their intention (to terminate the ongoing activity) when five minutes elapsed or whether they remembered in time but could not resist an urge to finish the task at hand (see e.g., Ovsiankina, 1928; cited in Lewin, 1926/1951). In the present study, we therefore were careful to ensure that it was necessary to interrupt the

ongoing activity in order to carry out a prospective memory task and this was not confounded with the need to terminate this activity prior to its natural conclusion. Thus, children in the interruption condition could resume their ongoing picture naming task immediately after they had hidden the target picture.

The analyses of data obtained in all of the three experiments confirmed our hypothesis about the effects of task interruption on prospective memory. Task interruption consistently explained a significant amount of variance in prospective memory (particularly in Experiments 1 and 2) and had high levels of power. However, given a lack of previous research on this topic this finding needs to be treated with some caution. It is possible that smaller effect sizes may be obtained with different age ranges, prospective memory tasks and/or materials. [7] Obviously, future studies are needed to confirm the robustness of this finding.

At this stage one can only speculate about the reasons for the strong effect of interruption obtained in the present study. One explanation is related to the procedures that were employed. Although all prospective memory tasks studied in a laboratory necessitate an interruption of an ongoing activity this interruption is usually very short lived (e.g., pressing a key, circling a target word, etc.). In the present study, children in the interruption condition had to stop the picture naming task for about 5-6 seconds in order to hide the target card. Consequently, it may be that because we employed procedures with a marked disengagement from the ongoing activity this resulted in a large difference between the interruption and no interruption conditions.

Another way of accounting for the effect of interruption is to assume that when the children were naming the cards, most of their attentional resources were taken up by this task, and they were less likely to remember to hide a target card with an animal on it (despite the fact that they could clearly see the animal and, in addition, had to name it aloud). When, however, the animal card occurred as the last one in the

stack, the children named it and because they were not engaged in any other activity for the following few seconds, more resources may have been available to recognize the animal card as the target for the requested action (cf. Einstein & McDaniel, 1996; Ellis & Milne, 1996). Therefore, one could argue that the effect of interruption would be attenuated if one employed an ongoing task that requires minimal attentional resources from children.

A final set of findings obtained in the present study concerns the relation between prospective and retrospective memory. This topic is undoubtedly an important one, but so far only limited advances in understanding have been made. A number of studies have, by and large, failed to establish reliable correlations between prospective and retrospective memory in adults(e.g., Einstein & McDaniel, 1990; Kidder, Park, Hertzog, & Morrell, 1997; Kvavilashvili, 1987; Maylor, 1990; Meacham & Leiman, 1982). It has also been argued that since retrospective memory tasks themselves do not necessarily correlate with each other (e.g., Underwood, Boruch, & Malmi, 1978) it is more fruitful to investigate whether certain variables exert similar influences on both types of memory (e.g., McDaniel, 1995; McDaniel & Einstein, 1993). A recent and promising line of research in this respect involves neuropsychological enquiries into the existence of single and/or double dissociations between prospective and retrospective memory (Bisiacchi, 1996; Burgess & Shallice, 1997) and the involvement of different or similar brain regions in these two types of tasks (Glisky, 1996; McDaniel, Glisky, Rubin, Guynn, & Routhieaux, 1999).

It is interesting that in Experiment 3 different patterns of results emerged for children's prospective and retrospective memory scores. In the analyses of variance the effect of age explained twice as much variance in retrospective than in prospective memory scores. Moreover, in the regression analyses on prospective memory scores the effect of age was not significant when all the other predictor variables were

controlled for, whereas in the similar analysis on retrospective memory scores age came out as a significant predictor. Finally, the results of the regression analyses also showed that there was no relationship between children's prospective and retrospective memory scores. These findings are indicative of a difference in the development of prospective and retrospective memory. They also support the idea that although prospective and retrospective memory may involve similar components of the memory system, the demands placed on these components may be very different (e.g., Kvavilashvili, 1987; Maylor, 1990; but see Roediger, 1996 and Hunt & Smith, 1996 for an opposing viewpoint).

Having discussed three major findings obtained in the present study it is appropriate to ask how they inform the current theoretical models of prospective memory before we move to discussing their practical and methodological implications. A major question about prospective memory concerns whether it is predominantly an automatic process or requires certain amount of controlled attentional resources. If our line of reasoning about the involvement of attentional resources in the task interruption effect is correct then one could argue that present findings provide some support to a noticing+search model proposed by Einstein and McDaniel (1996).

According to this model prospective remembering involves a two-stage process in which encountering a target event will automatically elicit a feeling of familiarity (i.e., noticing) followed by a controlled search for an intended action. Although, at an intuitive level, prospective remembering seems to be an automatic process as intentions often are reported to simply "pop into one's mind" the existence of a controlled stage in this process can be inferred from recent experiments using dual task paradigms in which prospective memory was found to be significantly impaired if an ongoing task was attentionally demanding (see Einstein, Smith, McDaniel, &

Shaw, 1997; Marsh & Hicks, 1998; for neuropsychological evidence see McDaniel et al., 1999). In the present study, it seems likely that the controlled search component of the noticing+search process would be more problematic for children in the interruption condition, given the concurrent demands of picture naming.

On the other hand, it is often supposed that automatic cognitive processes are relatively unaffected by developmental change (see Hasher & Zacks, 1979). Therefore, the small age effects obtained in the present study seem to be congruent with models which stress the automatic nature of retrieval in prospective memory tasks. Indeed, according to simple activation models (Einstein & McDaniel, 1996; Ellis, 1996; Goschke & Kuhl, 1996; Mäntylä, 1996) when a person encounters a prospective memory target the latter enhances the levels of activation of intention representations which results in automatic retrieval of a prospective memory task.

Thus, the findings of the present study, concerning the effects of age and task interruption, support two different accounts of prospective memory. It is interesting, however, that McDaniel, Robinson-Riegler and Einstein (1998) have recently proposed a more detailed version of activation model which tries to reconcile the automatic nature of prospective memory retrieval with the prospective memory impairment under divided attention conditions (see also Einstein & McDaniel, in press). Their ideas are based on systems view of memory (see Moscovitch, 1994) and assume that prospective memory is mediated by a reflexive associative memory system subserved mainly by the hippocampus.

McDaniel et al. (1998) stress the importance of automatic associative links between a prospective memory cue event and an intended action. Since their model rejects the necessity of a second controlled stage in prospective memory retrieval they propose the following two possibilities to explain the effects of divided attention on prospective memory. First, McDaniel et al. (1998) suggest that under divided

attention conditions it is unlikely that a cue event will receive sufficient attention to enable the automatic link to occur between the cue and a relevant memory trace (i.e., an intended action) (for similar suggestion, see Marsh & Hicks, 1998). Second, they suppose that even when an intended action is automatically retrieved it may be immediately forgotten in the face of competing demands imposed by divided attention.

If the latter suggestion is correct then the results of the present study could be accommodated by McDaniel et al.'s (1998) model. Thus, the idea that the retrieval of intention is largely an automatic process is consistent with the small age effects observed in our study. In addition, the idea that automatically retrieved intentions can be easily forgotten in face of competing demands of an on going activity(s) is consistent with the finding that prospective memory performance was worse in the interruption than no interruption condition. It is obvious, however, that in future more research needs to be carried out both on adults and children to explore the mechanisms that underlie the effects of divided attention and task interruption on prospective memory. Such studies will undoubtedly enable the further development and refining of current models of prospective memory.

Practical Implications. The results of the present study provide some simple guidelines to parents and teachers about the ways to enhance success in prospective memory tasks. Since children's prospective memory has been shown to be significantly influenced by task interruption, it is desirable that the caregivers try to ensure that children will not be engaged in an activity when the prospective memory task should be carried out. This could be achieved by deliberately assigning children to the so called activity-based tasks which require them to do something only before the onset or after finishing a certain pre-specified activity (see Kvavilashvili & Ellis, 1996). A further possibility, based on previous investigation of the benefits of

external cueing in children's prospective memory performance (Meacham & Colombo, 1980), is that a combination of an activity-based task with external cueing could be most beneficial in ensuring that children carry out their intentions on time (e.g., a tooth brush could be placed upon the child's pillow to remind the child to brush his/her teeth before going to bed).

Methodological Implications. The present study has shown that prospective memory can be investigated in controlled situations with a simple and engaging task in children as young as four years of age (cf. Guajardo & Best, 2000). This can be considered an improvement over the single-intention paradigm (see Kvavilashvili, 1992) employed by Meacham and his colleagues in which only a single yes/no response was obtained because there was only one retrieval opportunity. Our paradigm permits the collection of several responses in a single session. Furthermore, the use of a standardized setting provides the control necessary to eliminate the influence of extraneous or confounding variables which may be present in other investigations (e.g., Somerville et al., 1983). In addition, since the ongoing task involves naming the pictures and not reading the words (see Passolunghi et al., 1995), there is also a potential for our method to be used in two or three year old children.

We were also careful to ensure that prospective memory failures were not due to retrospective forgetting of the contents of prospective memory task. Thus, the post experimental probing of those children who forgot to hide a card on all four occasions revealed that they were aware that they had been requested to carry out the prospective memory task. On the other hand, the post experimental questioning of those children who remembered to hide the target card on at least one occasion, revealed that the majority of children (74% in Experiment 1 and 62% in Experiment 2) did not constantly think about the to-be-performed action throughout the

experimental session. Similar reports have been obtained in studies with adults (see Kvavilashvili, 1998).

An important feature of prospective memory in everyday life is that once an intention is formed it is no longer necessary to think about it obsessively. Instead, a person switches to another activity (cf. Meier & Graf, in press). However, at an appropriate moment, the prospective memory task tends to spring to one's mind, often without any obvious external cue (see Freud, 1966 for a detailed description of this phenomenon). It thus appears that the task employed in the present study adequately captures the most important features of prospective remembering as revealed in everyday life and enables quantitative measures of prospective memory to be obtained within a single and relatively short experimental session.

One potential drawback of the present method is that children in all age groups had to name the same number of cards. Given that there was a highly significant age effect in the time spent on naming the cards, [8] there is a danger that the background task was more demanding for the younger children. In future research it is perhaps advisable to make adjustments in the number of to-be-named cards according to the age of the children so that children in all age groups spend approximately the same amount of time on naming a stack of cards (e.g. see Messer, Kvavilashvili, & Kyle, 1998). A special care should be also taken to make sure that remembering the contents of the to be performed action does not pose any demands on children's retrospective memory. In the present series of experiments there was some indication that younger children who forgot on all four occasions required more prompting than 7-year-olds in order to be able to recount the contents of the prospective memory task (see Table 5).

In conclusion, given the early stage of research on children's prospective memory abilities, the results of the present study are both interesting and encouraging. They show that research on young children's prospective memory performance is

feasible and may produce data that can have important theoretical and practical implications for prospective memory research in general and memory development, in particular.

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Footnotes

[1] Two points need to be stressed in relation to prospective memory instructions. First, children could not see the box while sitting at the table unless they got up and turned around. In this way it was ensured that it could not serve as an incidental cue reminding the children of prospective memory task. Second, the prospective memory instructions did not allow a child to know when exactly would the animal picture occur (i.e., in the middle or the end of the stack). In fact, the children did not even know whether the animal card would be in all or only some of the stacks.

[2] When designing Experiment 1 it slipped our attention that the last drawing that the child had to draw - the sheep - belonged to an animal category and could potentially serve as a prospective memory target. However, none of the children ever commented on this connection when asked to draw a picture of the sheep. Neither did they act prospectively (i.e., hid the drawing) once the picture was completed.

[3] It should be pointed out that these percentages are very similar to the ones reported in several studies on adults in which the majority of participants also remembered or forgot prospective memory task on all target occasions (e.g., see Einstein & McDaniel, 1990; McDaniel & Einstein, 1993).

[4] Unfortunately, due to the experimenter error, the data about the type of prompt (general vs. intermediate vs. specific) which made the children to retrospectively recall the prospective memory instructions was missing. Therefore we could not make age comparisons in this respect (however, see the results section of Experiments 2 and 3).

[5] After we conducted Experiment 2, Cycowicz, Friedman and Rothstein (1997) published normative data for the pool of Snodgrass and Vanderwart (1980)

pictures for five to seven year old children. The mean familiarity ratings of the pictures in four stacks of cards based on the normative data for children were 2.91, 2.79, 2.77 and 2.76 for Stack 1, Stack 2, Stack 3 and Stack 4, respectively ($\underline{F} < 1$). The lower familiarity ratings on the normative data for children reflect the fact that "young children show a smaller range and less variation in their ratings of familiarity" (p. 182; Cycowicz et al., 1997).

[6] However, this comparison should be taken with caution since prospective and retrospective memory scores were based on different amounts of data points, i.e., four in the former and 10 or 20 in the latter.

[7] It should be noted that the smaller effect size was obtained even in the present study (in Experiment 3) when we controlled for the confounding variable.

[8] In Experiment 1 we entered the time (in seconds) spent on naming the stacks as the dependent variable in a 2 (age) x 2 (task interruption) x 4 (stacks) mixed analysis of variance with the repeated measures on the last factor. This analysis revealed a highly significant main effect of age, $\underline{F}(1,44) = 35.01$, $\underline{p} < .0005$ indicating that, on average, 7-year olds were quicker at naming the cards than 5-year olds ($M_1 = 58.29$ and $M_2 = 76.42$, respectively). There was also a reliable effect of stacks, $\underline{F}(3,132) = 12.26$, $\underline{p} < .0005$ so that, on average, children tended to spend significantly more time on naming the first stack ($M_1 = 75.08$) than on each of the subsequent stacks ($M_2 = 66.92$, $M_3 = 64.42$, and $M_4 = 63.00$ for the second, third and fourth stack, respectively) (all $\underline{p}_s < .0005$). There was no significant effect of task interruption and there were no interactions between independent variables. The same pattern of results was obtained in Experiments 2 and 3.

Table 1

The Number of Children in Experiments 1, 2 and 3 Who Remembered to Perform a Prospective Memory Task on All Four Occasions, on None of the Occasions or on Only Some (One, Two or Three) Occasions as a Function of Age and Task Interruption

	INTERRUPTION				NO INTERRUPTION			
	All	None	Some	Total	All	None	Some	Total
Experiment 1								
5 years	1	9	2	12	7	1	4	12
7 years	5	5	2	12	10	2	0	12
Total	6	14	4	24	17	3	4	24
Experiment 2								
4 years	3	11	6	20	12	7	1	20
5 years	5	11	4	20	15	4	1	20
7 years	11	8	1	20	19	1	0	20
Total	19	30	11	60	46	12	2	60
Experiment 3								
4 years	3	12	1	16	10	6	0	16
5 years	7	6	3	16	10	5	1	16
7 years	6	6	4	16	14	2	0	16
Total	16	24	8	48	34	13	1	48

Table 2

Mean Number of Successful Prospective Memory Responses as a Function of Age and Task Interruption in Experiments 1, 2 and 3 (Standard Deviations in Brackets)

	Interruption	No interruption
Experiment 1		
5 years	.58 (1.24)	2.83 (1.59)
7 years	2.17 (1.95)	3.33 (1.56)
Experiment 2		
4 years	1.25 (1.62)	2.55 (1.93)
5 years	1.35 (1.75)	3.10 (1.65)
7 years	2.30 (1.98)	3.80 (.89)
Experiment 3		
4 years	.94 (1.69)	2.50 (2.00)
5 years	2.06 (1.91)	2.68 (1.89)
7 years	2.25 (1.84)	3.50 (1.36)

Table 3

The Number of Children (Remembering Prospective Memory Task on at Least One or More Occasions) in Experiments 1, 2 and 3 who Reported either Having Remembered the Intention Only when Seeing the Target Picture or Having Thought about it All the Time

	SELF-REPORTS		
	Remembering only when seeing the card	Thinking about the task all the time	Total
Experiment 1			
5 years	11	3	14
7 years	12	5	17
Total	23	8	31
Experiment 2			
4 years	7	2	9 *
5 years	17	8	25
7 years	16	15	31
Total	40	25	65
Experiment 3			
4 years	8	2	10
5 years	10	8	18
7 years	16	7	23
Total	34	17	51

* Note, that due to experimenter error the data of thirteen 4-year-olds are missing.

Table 4

The Number of Children in the Interruption and the no Interruption Condition in Experiment 2 and Experiment 3 (Collapsed Across the Age Variable) who Remembered or Forgot to Hide a Target Picture in Stack 1

	Prospective memory performance on the first target		
	Remember	Forget	Total
Experiment 2			
Interruption	21	39	60
No interruption	47	13	60
Total	68	52	120
Experiment 3			
Interruption	23	25	48
No interruption	35	13	48
Total	58	38	96

Table 5

The Number of 4-, 5-, and 7-year-old Children in Experiment 2 and Experiment 3 who Forgot to Hide the Target Cards on all Four Occasions but Retrieved Prospective Memory Task at the End of Experiment either on the Very First Prompt or on Subsequent More Specific Prompts

	PROMPTS		
	First	Second & third	Total
Experiment 2			
4 years	5	13	18
5 years	5	10	15
7 years	5	4	9
Total	13	29	42
Experiment 3			
4 years	0	16	16
5 years	0	9	9
7 years	4	4	8
Total	4	29	33

Table 6

The Mean Proportions of Correctly Recalled Items from the Last Stack of Cards (Retrospective Memory Test) as a Function of Age and Task Interruption in Experiment 3 (Standard Deviations in Brackets)

	Interruption	No interruption
4 years	.07 (.06)	.19 (.12)
5 years	.11 (.08)	.19 (.15)
7 years	.17 (.11)	.31 (.15)

Table 7

Standardized Beta Coefficients for Regression Analyses Predicting Prospective Memory and Retrospective Memory Scores in Experiment 3. Each Column Represents a Separate Multiple-regression Analysis.

	Criterion variable	
Predictor variable	Prospective memory	Retrospective memory
Age	.17	.33 **
Task interruption	.22 *	.34 **
Retrospective memory	.18	–
Prospective memory	–	.15
R^2	.14	.28

* $p < .05$

** $p < .001$

Author Note

Part of this research has been supported by a grant from The Leverhulme Trust (F/281/E). We are grateful to Kate St. John and Anne Hagues for assistance with data collection and to the following local schools who participated in this research: Salisbury Infants School and Stream Woods JMI School in Hatfield, Ludwick Nursery in Welwyn Garden City, Cuffley School in Cuffley, Oxhey Nursery and Bromet JMI School in Watford. We also wish to thank Diana Kornbrot, Pam Smith, Richard Young, Tina Gutbrod and anonymous reviewers for their useful comments on earlier drafts of this paper.

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